TOPIC:	Wildland Fire Behavior - Fuels
TIME FRAME:	1:00
LEVEL OF INSTRUCTION:	Level I
BEHAVIORAL OBJECTIVE:	
Condition:	A written quiz
Behavior:	The student will list and describe fuel characteristics important to fire behavior and describe how physical characteristics and moisture content of fuels affect rate of spread and fire intensity.
Standard:	With a minimum of 80% accuracy

MATERIALS NEEDED:

- Appropriate visual aids
- Audio visual equipment

REFERENCES:

- CAL FIRE, Wildland Urban Interface Operating Principles, 1st Edition, Ch. 2
- Teie, Firefighter's Handbook on Wildland Firefighting, 3rd Edition
- NWCG: S-290 Fire Behavior (2007) Fuels & Fuel Moisture

PREPARATION:

CAL FIRE firefighters are routinely called upon to suppress wildland fires throughout the state. Because of the diversity of fuel types and fuel conditions that may be encountered, it is important that you be able to recognize and anticipate fire behavior problems associated with those fuels.

PRESENTATION	APPLICATION

I. INTRODUCTION

A. The combustible components of virtually all wildland fuels are:

1. Cellulose
2. Lignin
3. Flammable waxes, oils, and resins

B. Variations in the flammability of wildland fuels are dependent on:

1. Physical characteristics (geometry)
2. Live or dead fuel moisture content
3. Evergreen vs. deciduous type
4. Chemical content

II. FUELS TERMINOLOGY

A. Common terms used to describe fuels by type:

1. Grass
2. Brush
3. Timber
4. Litter
   a. The loose layer of dead twigs and branches, leaves, and needles on the surface beneath trees or brush
5. Duff
   a. The layer of decaying organic material between the litter and the soil

PRESENTATION	APPLICATION

6. Slash

   a. Heavy dead fuels including logs and branches lying on the surface

   b. Produced when logging or other damage has removed the tree stand

B. Terms used to describe fuels by position

Information sheet #1

1. Aerial fuels

   a. The mass of foliage in trees or brush that lies well above the surface (generally greater than 4 feet high)

   b. These become involved under severe conditions and create the highest intensity fires

2. Surface fuels

   a. Those fuels lying on or contiguous with the ground surface

   b. Such as litter, grass, down dead material, small brush

   c. These carry most fires

3. Ground fuels

   a. Duff, highly organic soil, buried logs or branches, roots

   b. These mostly smolder and create mop-up problems

PRESENTATION	APPLICATION
III. ADDITIONAL PHYSICAL CHARACTERISTICS	
	Information sheet #2
A. Fuel loading	
1. The total weight of vegetation on a unit area of land	
2. Ranges from a few tons per acre for grass to hundreds of tons per acre for timber and slash	
B. Fuel availability	
1. The percentage of fuel that will be consumed by a fire	
2. It is near 100% for cured grass	
3. Standing timber is 10% or less consumption	
C. Surface-to-volume ratio (S/V)	
1. Fuel surface area compared to the fuel volume	
a. Greater for fine or flattened fuels such as grass or leaves	
b. Less for large fuels such as logs and branches	
c. Higher surface to volume ratio means	
(1) More rapid drying/wetting	
(2) More rapid ignition	
D. Vertical arrangement	
1. The distribution of fuel from bottom to top of the fuel complex	

PRESENTATION	APPLICATION
	Information sheet #3

a. Vertically oriented fuels burn better (standing grass vs. fallen grass)

b. Ladder fuels help spread surface fire into the aerial fuels

E. Horizontal continuity

1. How continuous or how broken the fuel is across the landscape

   a. Continuous fuels promote fire spread

   b. In patchy fuels, fire spread is impeded

   c. Regaining intensity/spread in the thicker fuels

F. Compactness

1. The degree of closeness or openness between fuel particles

   a. Open fuels, such as grass, promote flame front spread

      (1) Unless they are too open or sparse

      (2) Largely because oxygen has free access

   b. Compact fuels generally burn slowly

      (1) Often are more receptive to ignition by fire brands (as in compact litter or decaying wood)

      (2) The heat of a brand is not lost rapidly

PRESENTATION	APPLICATION

G. Dead-to-live ratio

1. The amount of dead material attached compared to the amount of attached living foliage

   a. Dead to live ratio increases with age of the stand or with damage that kills some parts of plants (insects, disease, fire, snow, wind, cold)

   b. Generally higher dead to live ratio means more flammable fuels, especially in brush

IV. FUEL MOISTURE

A. Amount of water held in the tissues of vegetation

1. Expressed as a percentage

   a. The weight of water compared to weight of the dried plant material

2. Strongly influences the flammability of vegetation

B. Fuels are classified as either "Dead" or "Live"

1. They follow very different moisture patterns

   a. Dead fuels are classified by the approximate time it takes them to respond significantly to drying or wetting trends

      (1) 1-hour : 0" to 1/4" in diameter

      (2) 10-hour : 1/4" to 1" in diameter (the "fuel stick")

PRESENTATION	APPLICATION
	The fuel stick is used in field weather stations to represent 10-hour fuels
(3) 100-hour : 1" to 3" in diameter	
(4) 1000-hour: 3" to 8" in diameter	
(5) 10,000-hr: Greater than 8" in diameter related to the ERC (drought)	Energy release components

C. Dead Fuel Moisture

1. Controlled by atmospheric moisture (as humidity and sometimes precipitation)

   a. Dead materials exchange moisture with water vapor in the air constantly

      (1) Over time reaches a fuel moisture level that is in balance with the prevailing relative humidity

      (2) Equilibrium moisture content

   b. It takes "X" time for dead fuels to respond significantly to humidity changes

      (1) Minutes for grass

      (2) Hours for twigs

      (3) Days for branches

      (4) Weeks for logs

PRESENTATION	APPLICATION

2. The fine and small dead fuels are usually responsible for carrying the flaming front

   a. Dead fuel moisture greatly affects fire spread and intensity

D. Live fuel moisture

1. Controlled by

   a. Plant species

   b. Soil moisture

   c. Plant morphology (growing cycle)

   d. The plant's moisture regulating its growing cycle

   e. Its water requirement

2. In general, the live fuel moisture is highest with the new growth of spring or early summer

3. Live fuel moisture declines throughout the summer, reaching its lowest level in the fall

4. Live fuel moisture ranges from near 300% down to about 50% (different ranges for different species and locale)

5. Live fuel moisture levels have a major influence when fire will spread through the crowns of brush or timber

Fire Protection Training
Procedures Handbook 4300
WILDLAND FIRES

SUMMARY:

Understanding how fuels affect fire spread and intensity is very important to safe fire control operations.

EVALUATION:

A written quiz.

ASSIGNMENT:

To be determined by instructor(s).